

Monitoring Bone Health after Spaceflight: Data mining to support an epidemiological analysis of age-related bone loss in astronauts.

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INTRODUCTION

Four human health risks for the skeletal system are perceived to be induced, or increased as a consequence of future exploration missions. One of those risks, the Risk for Accelerated Osteoporosis has its impact on the long-term health of the crewmember and potentially on future planned planetary missions. Osteoporosis is a skeletal condition hallmarked by *low bone mass* and *severe structural deterioration* that can lead to fractures occurring as a result of low trauma or even under normal mechanical loading. This skeletal fragility is often associated with the elderly because of the cumulative effects of age-related bone loss. Thus, substantiating the risk for “accelerated osteoporosis” in crewmembers after prolonged spaceflight exposure requires demonstrating i) lower bone density at an earlier age than expected when compared to terrestrial peer groups; ii) the occurrence of low trauma fractures at an earlier age than expected and iii) a greater incidence of fractures in the former crewmembers compared to their terrestrial peer group.

The Longitudinal Study of Astronaut Health is a prospective study in which the surveillance of age-related skeletal changes is being conducted. In addition, this year the Human Research Program has funded “An epidemiological study of risk factors for bone loss and recovery related to long-duration spaceflight.” to address how skeletal adaptation in space may influence age-related bone loss in the long-duration crewmember, long-term. The goals of this research are 1) to explore risk factors that may explain the variability in the changes in bone mineral density [BMD] observed data that are collected in the long-duration crewmembers, 2) to provide a comprehensive summary of the current evidence on bone health of crewmembers after long-duration space missions and, most importantly, 3) to compare the observed relations in these crewmembers with the age- and sex-matched expected relations derived from a population-based study., to the Mayo Clinic Rochester Bone Health Study.

To support this upcoming study, we evaluated the success rate by which NASA collects serial measurements of bone health for the long-duration crewmembers during the post-flight period and for all astronauts following their NASA career. We tallied the number of total number of astronauts per spaceflight missions (Shuttle, Skylab, Mir and ISS) and surveyed how much post-flight BMD data have been collected to-date. Additionally, we extracted the regional BMD data of long-duration crewmembers over multiple skeletal sites. Our results have also documented that the periodic, long term surveillance of skeletal health in long-duration crewmembers, and in all astronauts in general, is not 100% due to a variety of factors which are currently being addressed.

SUMMARY

Through the epidemiological analysis of bone data, HRP is seeking evidence as to whether the prolonged exposure to microgravity of low earth orbit predisposes crewmembers to an earlier onset of osteoporosis. While this collaborative Epidemiological Project may be currently limited by the number of ISS persons providing relevant spaceflight medical data, a positive note is that it compares medical data of astronauts to data of an age-matched (not elderly) population that is followed longitudinally with similar technologies. The inclusion of data from non-ISS and non-NASA crewmembers is also being pursued.

CONCLUSION

The ultimate goal of this study is to provide critical information for NASA to understand the impact of low physical or minimal weight-bearing activity on the aging process as well as to direct its development of countermeasures and rehabilitation programs to influence skeletal recovery. However, in order to optimize these results NASA needs to better define the requirements for long term monitoring and encourage both active and retired astronauts to contribute to a legacy of data that will define human health risks in space.